

# HERACLES and DJANGO6: Updates for version 4.6.8

H. Spiesberger

Institut für Physik, Johannes-Gutenberg-Universität,  
Staudinger Weg 7, D-55099 Mainz, Germany

e-mail: `spiesber@uni-mainz.de`

April 6, 2011

## **Abstract**

Modifications introduced into DJANGO6-4.6.8 to allow calculations for nuclear targets.

## 1 File lhaglu-copy.f

- Parton distribution functions from LHAPDF required a modification in `lhaglu.f`. The modified version, `lhaglu-copy.f` is part of the DJANGO source code now.
  - Removed reference to common block `/ludat1/` because of type mismatch with JETSET 7.4; removed the corresponding assignment to unused `mstu5(11)`.
  - To allow use of nuclear corrections from [3, 4, 5] via calls to `structm` from PYTHIA, `structm` in `lhaglu-copy.f` has been renamed to `structf` and `structa` into `structm`. The argument list of `structa` is shortened: the nuclear number `a` is transferred via the common block `/HSNUCL/` from DJANGO.

## 2 File djangoh.h.f:

- To allow linkage to the LHAPDF library [1], initialization of the path to the PDFsets folder has been introduced in subroutine `HSWPDF` and the path name has to be provided in the input file with code word `LHAPATH`:

`LHAPATH`: Path name to the PDFsets folder of LHAPDF, character\*80, no default defined.

The code was tested with LHAPDF versions 5.8.4 and 5.8.5.

- The new code word `NUCL-MOD` with input `INUMOD` (integer, default = 0) has been introduced to select a model for nuclear shadowing or nuclear parton distribution functions.

The variable `INUMOD` extends the common block `/HSNUCL/`.

`INUMOD = 0`: No correction. Parton distribution functions are used as selected by `ILQMOD`, `ILIB`, `ICODE` from code word `STRUCTFUNC`.

This is the appropriate setting if nuclear parton distribution functions like those from [2] are used which incorporate nuclear effects.

`INUMOD = 1000`: Structure functions are calculated from the isoscalar average of unmodified parton distribution functions and a  $Q^2$ -independent correction factor. The same correction factor is applied to both  $F_2$  and  $F_L$ .

`INUMOD = 2000`: Apply correction factors to free parton distribution functions from EKS98 [3].

`INUMOD = 3000`: Apply correction factors to free parton distribution functions from EPS08 [4].

INUMOD > 4000: Apply correction factors to free parton distribution functions from EPS09 [5].

LO or NLO fits (`iorder` = 1 or 2) and the error set `ipset` = 1, ..., 23, are selected according to `INUMOD = 100×iorder + ipset`.

The EPS09 analysis is based on CTEQ6.1M partons, but any PDF set can be combined with the nuclear corrections in this scheme.

Code in subroutines `HSSTRF` and `HSSTR1` has been reorganized to allow for this option.

### 3 Usage

- Input to code word `NUCLEUS` is `EPRO`, the energy per nucleon, and `HNA` (nucleon number) and `HNZ` (proton number).
- Parton distribution functions are used from LHAPDF [1] if `ILQMOD`=0 and `ILIB`=2. Important values for the PDF set are

`ICODE` = 10150: CTEQ61M. Note that this set was used as a reference in the EKS and EPS fits of nuclear correction factors to the PDFs.

`ICODE` = 10550: CTEQ66.

`ICODE` = 29061: MRST98dis.

`ICODE` = 100151: HKNNlo for proton; in general: 100150+ $n$  with  $n$  = 2 (deuteron),  $n$  = 3 (Helium),  $n$  = 6 (C),  $n$  = 17 (Au),  $n$  = 18 (Pb), etc.

- For a test run, see the input file `erhic-nlo+fl+frag.in`, the corresponding output file is `erhic-nlo-test.in` and the event listing written from subroutine `HSUSER` (see file `djangoh_u.f`) can be found in `event-nlo-test.dat`.  
Generation of 1,000,000 events (including  $F_L$  and fully fragmented) took about 14 minutes on `eic0001.rcf.bnl.gov` ( $7.5 \times 10^{-4}$  sec per event plus initialization).

### References

- [1] M. R. Whalley, D. Bourilkov and R. C. Group, arXiv:hep-ph/0508110. <http://hepforge.cedar.ac.uk/lhapdf/>.
- [2] M. Hirai, S. Kumano, T.-H. Nagai, Phys. Rev. **C76** (2007) 065207 [arXiv:0709.3038 [hep-ph]].

- [3] K. J. Eskola, V. J. Kolhinen and C. A. Salgado, Eur. Phys. J. C **9** (1999) 61 [arXiv:hep-ph/9807297].
- [4] K. J. Eskola, H. Paukkunen and C. A. Salgado, JHEP **0807** (2008) 102 [arXiv:0802.0139 [hep-ph]].
- [5] K. J. Eskola, H. Paukkunen, C. A. Salgado, JHEP **0904** (2009) 065 [arXiv:0902.4154 [hep-ph]].